CERTIFICATE OF VERIFICATION

I, Su Hyun LEE of 648-23 Yeoksam-dong, Kangnam-ku, Seoul, Korea state that the attached document is a true and complete translation to the best of my knowledge of the Korean-English language and that the writings contained in the following pages are correct English translation of the specification and claims of the Korean Patent Application No. P2000-35649.

Dated this 10th day of April, 2003.

Signature of translator: _____

Su Hyun LEE

(Translation)

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Commissioner

(Translation)

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[Title of Invention] MULTI DOMAIN LIQUID CRYSTAL DISPLAY DEVICE AND METHOD FOR FABRICATING THE SAME

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[Subject of application] Pursuant to Art. 42 of the Patent Law, we apply as above.

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[ABSTRACT OF THE DISCLOSURE] 00-35649

[ABSTRACT]

A multi-domain LCD device and a method for fabricating the same improve response time and picture quality. The multi-domain LCD device includes first and second substrates; a pixel electrode formed on the second substrate; a first side electrode formed along the periphery of the pixel electrode; a second side electrode formed in a diagonal direction of the pixel electrode; and first and second dielectric frames formed in the same direction as the second side electrode on the first substrate at both sides around the second side electrode. The method for fabricating a multi-domain LCD device includes the steps of. forming a first side electrode on a substrate in a matrix arrangement; forming a second side electrode to connect both ends with a corner portion of the first side electrode; forming a pixel electrode having a plurality of open regions at an upper side of the second side electrode; forming a color filter layer on the opposing substrate; forming a common electrode on the color filter layer; forming a first dielectric frame and a second dielectric frame on the common electrode corresponding to both sides of the second side electrode to pass through a central portion of the first side electrode; and forming a liquid crystal layer between the two substrates.

[TYPICAL DRAWINGS]

Fig 4a, Fig 4b

[INDEX]

disclination, liquid crystal

[SPECIFICATION]

[TITLE OF THE INVENTION]

MULTI-DOMAIN LIQUID CRYSTAL DISPLAY DEVICE AND METHOD FOR FABRICATING THE SAME

[BRIEF DESCRIPTION OF THE DRAWINGS]

Fig. 1 is a schematic view showing a general LCD device.

Fig. 2 is a sectional view showing a unit pixel of a related art multi-domain LCD device.

Fig. 3 is a plane view showing a multi-domain LCD device according to the first embodiment of the present invention.

Figs. 4a and 4b are partially detailed views of Fig. 3.

Fig. 5 is a sectional view taken along line A-A' of Fig. 3.

Figs. 6a to 6c are sectional views of fabricating process steps of a multi-domain LCD device according to the first embodiment of the present invention.

Fig. 7 is a plane view showing a multi-domain LCD device according to the second embodiment of the present invention.

Fig. 8 is a partially detailed view showing an open region of a first side electrode.

Description of reference numerals for main parts in the drawings

40, 49a: first and second substrates

41: pixel electrode

43, 45: first and second side electrodes

47, 47a: first and second dielectric frames

[DETAILED DESCRIPTION OF THE INVENTION]

[OBJECT OF THE INVENTION]

[FIELD OF THE INVENTION AND DISCUSSION OF THE RELATED ART]

The present invention relates to a display device, and more particularly, to a multi-domain liquid crystal display (LCD) device and a method for fabricating the same.

A Cathode Ray Tube (CRT) which is one of display devices is mainly used in monitors of information terminals and measuring instruments including TV. However, it was difficult for the CRT to actively adapt to miniaturization and light weight due to its weight and size.

To substitute for such a CRT, an LCD device having a small size, light weight and low power consumption has been actively developed. Recently, the liquid crystal display device can act as a flat panel display device. Thus, demand of the LCD device is on an increasing trend.

Such an LCD device is based on electric optical characteristic of a liquid crystal injected within a panel and does not emit light in itself unlike a plasma display panel (PDP) or a field emission display (FED). Accordingly, to view a picture displayed in an LCD, a separate light source, i.e., a back light assembly for uniformly irradiating light to a display panel of a picture is required.

Fig. 1 shows a general LCD. Referring to Fig. 1, the LCD includes a first substrate, a second substrate, and a liquid crystal injected and sealed between the first and second substrates.

In more detail, on the first substrate 11, a color filter layer 13 is formed to display color, a black matrix layer 15 is formed to prevent light from being transmitted to a portion other than a pixel region of the second substrate, a common electrode 17 is formed to apply a common voltage Vcom to the panel.

On the second substrate 21, a gate line 23 and a data line 25 are arranged to cross each other, so that a pixel region is formed in a matrix arrangement. A thin film transistor (TFT) and a pixel electrode are formed in each pixel region.

Recently, an LCD has been proposed, in which a liquid crystal is not aligned and is driven by auxiliary electrodes insulated from pixel electrodes.

Fig. 2 is sectional view of pixel unit of a related art LCDs.

A related art LCD includes a first substrate and a second substrate, a plurality of data lines and gate lines arranged in first and second directions on the first substrate to divide the first substrate into a plurality of pixel regions, a thin film transistor (TFT) formed on each pixel region of the first substrate and composed of a gate electrode, a gate insulating film, a semiconductor layer, an ohmic contact layer and source/drain electrodes, a passivation film 37 formed over the whole first substrate, a pixel electrode 13 formed on the passivation film 37 to connect with a drain electrode, and an auxiliary electrode 21 formed on the gate insulating film to partially overlap the pixel electrode 13.

On the second substrate, a light shielding layer 25 is formed to shield the light leaked from the gate and data lines and the TFT, a color filter layer 23 is formed on the light shielding layer 25, a common electrode 17 is formed on the color filter layer 23, and a liquid crystal layer is formed between the first and second substrates.

An open area 27 of the common electrode 17 and the auxiliary electrode 21 formed to surround the pixel electrode 13 distort the electric field applied to the liquid crystal layer, so that liquid crystal molecules in a unit pixel are driven variously. This means that when a voltage is applied to the LCD, dielectric energy due to the distorted electric field arranges the liquid crystal directors in needed or desired positions.

[TECHNICAL TASKS TO BE ACHIEVED BY THE INVENTION]

In the related art LCD, however, the common electrode or the pixel electrode requires the open area to obtain a multi-domain effect. Accordingly, the manufacturing process of the LCD further includes a step of patterning the electrodes.

Also, if the electrodes do not have the open area or the width of the open area is narrow, the electric field distortion needed for domain division to divide the pixel region becomes weak. Accordingly, the time needed to stabilize the liquid crystal directors increases, and luminance is reduced due to disclination.

Accordingly, the present invention is directed to a multi-domain LCD device and a method for fabricating the same that substantially obviates one or more of the problems due to limitations and disadvantages of the related art.

An object of the present invention is to provide a multi-domain LCD device and a method for fabricating the same, in which an alignment direction of liquid crystal molecules is controlled to improve response time and picture quality.

[PREFERRED EMBODIMENTS OF THE INVENTION]

To achieve these and other advantages and in accordance with the purpose of the present invention, as embodied and broadly described, a multi-domain LCD device which displays a picture image using electrical optical characteristic of a liquid crystal, includes first and second substrates; a pixel electrode formed on the second substrate; a first side electrode formed along the periphery of the pixel electrode; a second side electrode formed in a diagonal direction of the pixel electrode; and first and second dielectric frames formed in the same direction as the second side electrode on the first

substrate at both sides around the second side electrode.

In another aspect, a method for fabricating a multi-domain LCD device includes the steps of forming a first side electrode on a substrate in a matrix arrangement; forming a second side electrode to connect both ends with a corner portion of the first side electrode; forming a pixel electrode having a plurality of open regions at an upper side of the second side electrode; forming a color filter layer on the opposing substrate; forming a common electrode on the color filter layer; forming a first dielectric frame and a second dielectric frame on the common electrode corresponding to both sides of the second side electrode to pass through a central portion of the first side electrode; and forming a liquid crystal layer between the two substrates.

In the multi-domain LCD device according to the first embodiment of the present invention, the side electrode is formed across the pixel electrode in a diagonal direction as well as along the periphery of a pixel electrode, and the dielectric frames are formed at both sides around the second side electrode, thereby minimizing disclination therein.

In the multi-domain LCD device according to the second embodiment of the present invention, a region where electric field distortion is converged in the side electrode formed along the periphery of the pixel electrode is partially opened to minimize disclination therein. Also, it is intended to improve aperture as much as the open region.

A multi-domain LCD device according to the first embodiment of the present invention will now be described with reference to the accompanying drawings. .

Fig. 3 is a plane view showing a multi-domain LCD device according to the first embodiment of the present invention, and Fig. 4a shows a pixel electrode of Fig. 3 in more detail.

As shown in Fig. 3, in the first embodiment of the present invention, a first side electrode 43 is formed along the periphery of a pixel electrode 41, and a second electrode 45 is formed across the pixel electrode 41 in a diagonal direction to connect with the first side electrode 43. First and second dielectric frames 47 and 47a are formed in the same direction as the second side electrode 45 at both sides around the second side electrode 45.

As shown in the figures, the second side electrode 45 is formed in a diagonal direction of the pixel electrode so that liquid crystal molecules are uniformed arranged towards the second side electrode 45. The first and second dielectric frames 47 and 47a are formed on an opposing substrate corresponding to both sides of the second side electrode 45, so that the liquid crystal molecules are prevented from being abnormally prevented due to strong signal distortion at the central portion of the second side electrode 45.

The first and second dielectric frames 47 and 47a are dielectrics, and include a material such as acrylic or Benzocyclobutene(BCB) and black resin. Also, the first and second dielectric frames 47 and 47a are formed to pass through the central portion of the first side electrode 43.

Additionally, high molecules are formed on at least one of the first substrate 40 and the second substrate 40a to form a phase difference film (not shown). The phase difference film is a negative uniaxial film having one axis and acts to compensate a viewing angle of a user.

Therefore, a region having no gray inversion is expanded, contrast ratio in a tilt direction increases, and a multi-domain is formed by one pixel. Thus, a viewing angle in left and right directions can effectively be compensated.

In addition to the negative uniaxial film, a negative biaxial film having two axes may be formed as the phase difference film. The negative biaxial film having two axes can obtain viewing angle characteristic wider than the negative uniaxial film.

After attaching the phase difference film, a polarizer(not shown) is attached on the substrate. At the time, the polarizer may be formed in an integral form with the phase difference film.

Meanwhile, the pixel electrode 41, as shown in Fig. 4a, has an open region 49 in a diagonal direction. The open region 49 is formed to effectively control electric field that occurs between the pixel electrode 41 and the second side electrode 45 used to control the alignment direction of the liquid crystal molecules.

Fig. 4b shows the first electrode 43 and the second side electrode 45. Referring to Fig. 4b, the first and second electrodes 43 and 45 are integrally formed.

Fig. 5 is a sectional view taken along line A-A' of Fig. 3.

As shown in Fig. 5, a color filter layer 44 is formed on the first substrate 40 to display color, a common electrode 46 is formed on the color filter layer 44 to apply a common voltage Vcom to the pixel electrode, and first and second dielectric frames 47 and 47a are formed on the common electrode 46 at constant intervals.

The first and second side electrodes 43 and 45 are formed on the second substrate 40a to control the alignment direction of the liquid crystal molecules. An insulating film 42 is formed on an entire surface including the first and second side electrode 43 and 45. A pixel electrode 41 is formed on the insulating film 42, and has an

open region 49 at an upper side of the second side electrode 45.

In the aforementioned multi-domain LCD device according to the first embodiment of the present invention, the second side electrode 45 is formed to induce strong electric field in a diagonal direction of the pixel electrode, so that the liquid crystal molecules are uniformly arranged by the strong electric field of the first and second side electrodes 43 and 45.

Also, the first dielectric frame 47 and the second dielectric frame 47a are formed on the first substrate 40 in the same direction as the second side electrode 45, so that the liquid crystal molecules are prevented from being abnormally arranged in the central portion of the first side electrode 43 due to electric field distortion.

Accordingly, all the liquid crystal molecules within the pixel electrode are uniformly arranged towards the second side electrode 45.

The method for fabricating the multi-domain LCD device according to the first embodiment of the present invention will now be described.

Figs. 6a to 6c are sectional views of fabricating process steps of a multi-domain LCD device according to the first embodiment of the present invention.

As shown in Fig. 6a, the color filter layer 44 is formed on the first substrate 40 to display color, and the common electrode 46 is formed on the color filter layer 44 to apply the common voltage to the pixel electrode 41. Also, the first and second dielectric frames 47 and 47a are formed on the common electrode 46 at constant intervals.

As shown in Fig. 6b, the first and second side electrodes 43 and 45 are formed on the second substrate 40a to control the alignment direction of the liquid crystal molecules. The insulating film 42 is formed on the entire surface including the first and second side electrodes 43 and 45. The pixel electrode 41 having the open region 49 is

formed on the insulating film 42 at the upper side of the second side electrode 45.

Subsequently, as shown in Fig. 6c, the liquid crystal layer 60 is formed between the first and second substrates 40 and 40a. Thus, the fabrication process of the multi-domain LCD device according to the first embodiment of the present invention is completed.

The first dielectric frame 47 and the second dielectric frame 47a are formed in the same direction as the second side electrode 45 so that the liquid crystal molecules are prevented from being abnormally arranged due to electric field distortion in the central portion of the first side electrode 43.

A multi-domain LCD device according to the second embodiment of the present invention will be described in more detail.

In the multi-domain LCD device according to the second embodiment of the present invention, a region where electric field distortion is converged in the first side electrode formed along the periphery of the pixel electrode is partially opened to minimize disclination therein. Also, it is intended to improve aperture as much as the open region.

Fig. 7 is a plane view showing a multi-domain LCD device according to the second embodiment of the present invention, in which the first side electrode is partially opened, and Fig. 8 shows a portion where the first side electrode is to be substantially opened.

As shown in Fig. 7, the first side electrode 43 is formed in a matrix arrangement, and regions of a matrix arrangement are defined by the first side electrode 43. The pixel electrode 41 is formed on the matrix regions. The second side electrode 45 of which

both edges are connected with the first side electrode 43 is formed across the matrix regions in a diagonal direction.

The second side electrode 45 is formed in a zig-zag pattern. For instance, the second electrode 45 formed across one of the matrix regions and the second side electrode 45 formed across another region adjacent to the one region have a zig-zag pattern. This is to obtain a multi-domain by varying alignment directions of the liquid crystal molecules by the second side electrode 45.

The edges of the second side electrode 45 are connected with the first side electrode of a first direction (horizontal direction) and the first side electrode of a second direction (vertical direction). At least one of the first side electrode 43 of the first direction and the first side electrode 43 of the second direction which are adjacent to the edges of the second side electrode 45 is opened to be disconnected with the edges.

If the first side electrode 43 is electrically connected with the second side electrode 45 at the edges, the electric field distortion may occur in different directions. Accordingly, the first side electrode is partially disconnected within the range that the first side electrode 43 is not electrically disconnected with the second side electrode 45.

In other words, in Fig. 7, some of the first side electrodes 43 are not opened (dotted line). This is because that the second side electrodes 45 should form an electrical path without disconnection (for reference, hatched portions of Fig. 8 are opened).

If the first side electrode 43 corresponding to the dotted line of Fig. 7 is opened, the electrical path between the first side electrode 43 and the second side electrode 45 is disconnected. In this case, it is difficult to distort the electric field using the first and second side electrodes 43 and 45. For this reason, it is impossible to control the alignment direction liquid crystal molecules through the electric field distortion using

the side electrodes, thereby failing to obtain a multi-domain. Accordingly, it is required that the electrical path between the first side electrode 43 and the second side electrode is not disconnected.

If some of the first side electrode 43 is not disconnected, a signal is distorted in different directions in a region where the first and second side electrodes are converged. For this reason, disclination is caused, and aperture ratio is decreased due to the side electrodes.

Therefore, as shown in Fig. 7, some of the first side electrode 43 is opened in a region where the first side electrode 43 and the second side electrode 45 are converged, within the range that the side electrodes are not electrically opened, thereby preventing signal distortion in different directions from being generated.

As a result, the electric field distortion is formed in a direction of 45° and 135°, so as to minimize disclination in the region where the side electrodes are converged.

For reference, an insulating film (not shown) is formed on the first and second side electrodes 43 and 45, and the pixel electrode 41 is formed on the insulating film. The pixel electrode 41 has a plurality of open regions 49 at an upper portion of the second side electrode 45 (see Fig. 4a).

[ADVANTAGES OF THE INVENTION]

As aforementioned, the multi-domain LCD device and the method for fabricating the same have the following advantages.

Since the side electrodes are formed in a diagonal direction of the pixel region as well as the periphery of the pixel electrode, the liquid crystal is uniformly arranged to decrease the time needed to stabilize the liquid crystal directors, thereby decreasing

response time and minimizing disclination.

Since two dielectric frames are formed to correspond to the pixel region, the liquid crystal molecules are uniformly arranged in a diagonal direction of the pixel region through strong electric field distortion, thereby decreasing response time and minimizing disclination.

Finally, the side electrodes of the portion where the electric field distortion is converged are opened so as not to generate the electric field in different directions. Thus, it is possible to minimize disclination and at the same time improve an aperture ratio corresponding to the opened region, thereby improving picture quality.

What is claimed is:

1. A multi-domain LCD device which displays a picture image using electrical optical characteristic of a liquid crystal, comprising;

first and second substrates;

a pixel electrode formed on the second substrate;

a first side electrode formed along the periphery of the pixel electrode;

a second side electrode formed in a diagonal direction of the pixel electrode; and

first and second dielectric frames formed in the same direction as the second side electrode on the first substrate at both sides around the second side electrode.

2. The multi-domain LCD device of claim 1, further comprising an insulating film formed on the first and second side electrodes, the pixel electrode being formed on the insulating film.

3. The multi-domain LCD device of claim 1, wherein the pixel electrode has a plurality of open regions at an upper portion of the second side electrode.

4. A multi-domain LCD device which displays a picture image using electrical optical characteristic of a liquid crystal, comprising;

first and second substrates;

a first side electrode formed on the second substrate in a matrix arrangement;

a second side electrode of which both sides are connected with the first side electrode, formed across regions defined in a matrix arrangement by the first side

electrode in a diagonal direction; and

first and second dielectric frames formed in the same direction as the second side electrode on the first substrate at both sides around the second side electrode.

5. The multi-domain LCD device of claim 4, wherein at least one of the first side electrode in the first direction and the first side electrode in the second direction which are adjacent to both edges of the second side electrode is disconnected with the second side electrode.

6. The multi-domain LCD device of claim 4, wherein the second electrode formed across one of the matrix regions and the second side electrode formed across another region adjacent to the one region have a zig-zag pattern.

7. The multi-domain LCD device of claim 4, further comprising an insulating film formed on an entire surface including the first and second side electrodes, the pixel electrode being formed on the insulating film.

8. The multi-domain LCD device of claim 5, wherein the first and second side electrodes forms an electrical path.

9. The multi-domain LCD device of claim 4, wherein the first and second dielectric frames pass through a central portion of the first side electrode.

10. A method for fabricating a multi-domain LCD device comprising the steps

of:

forming a first side electrode on a substrate in a matrix arrangement;

forming a second side electrode to connect both ends with a corner portion of the first side electrode;

forming a pixel electrode having a plurality of open regions at an upper side of the second side electrode;

forming a color filter layer on the opposing substrate;

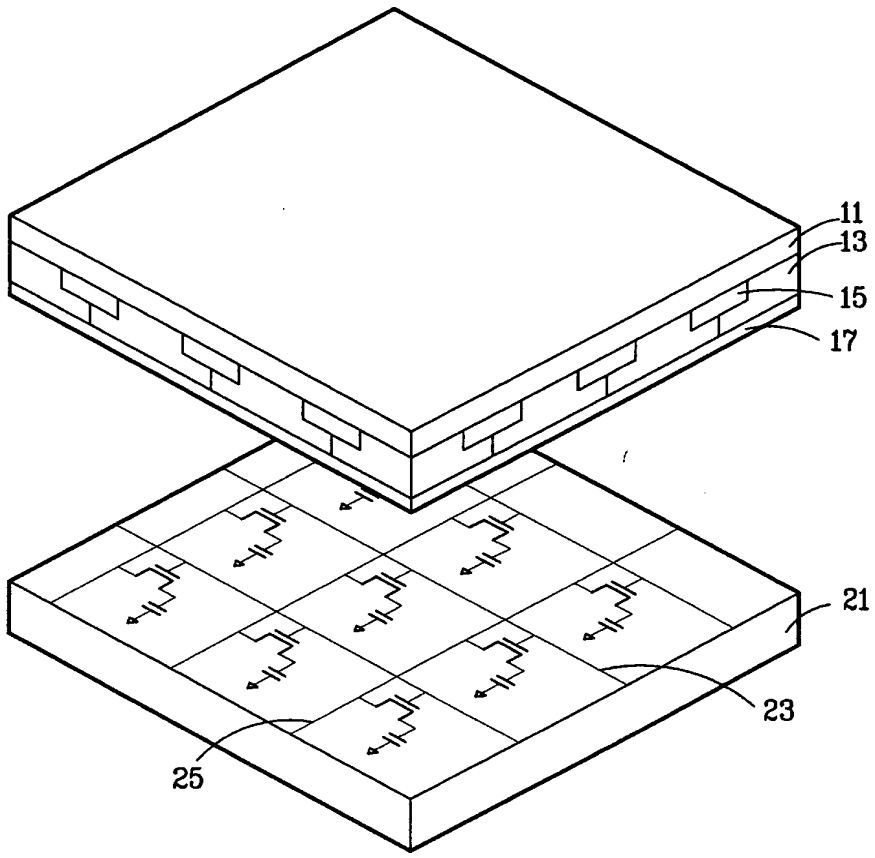
forming a common electrode on the color filter layer;

forming a first dielectric frame and a second dielectric frame on the common electrode corresponding to both sides of the second side electrode to pass through a central portion of the first side electrode; and

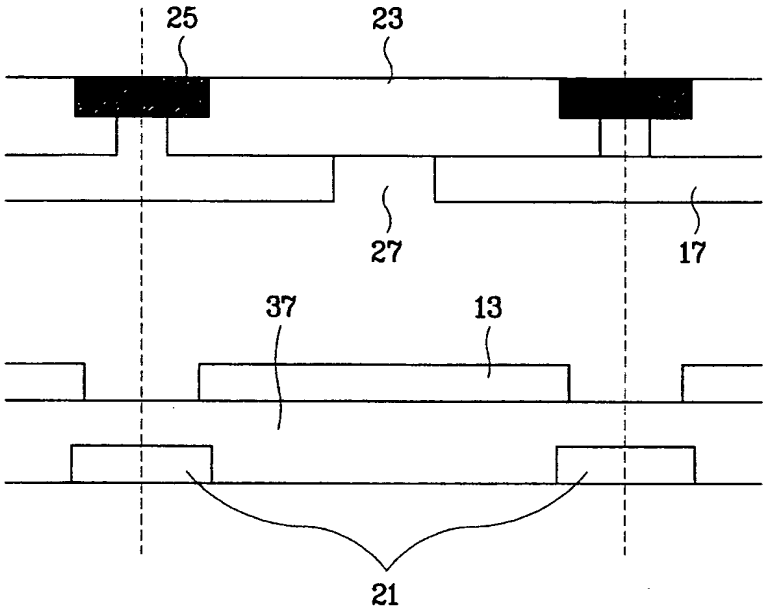
forming a liquid crystal layer between the two substrates.

11. The method of claim 10, wherein the first and second dielectric frames are formed of any one of photoacrylic, BCB, and black resin.

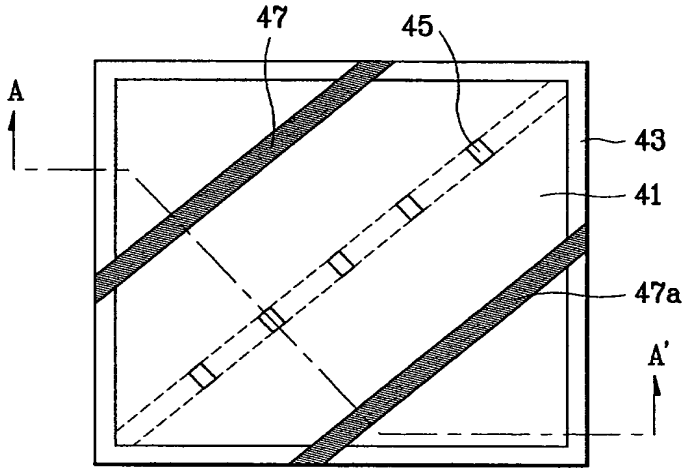
【Fig. 1】



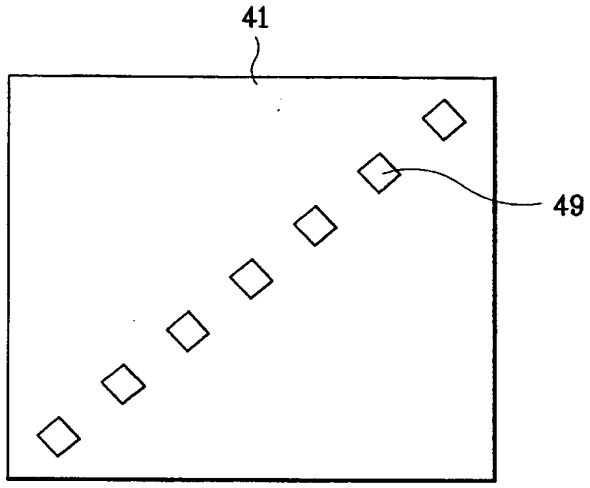
【Fig. 2】



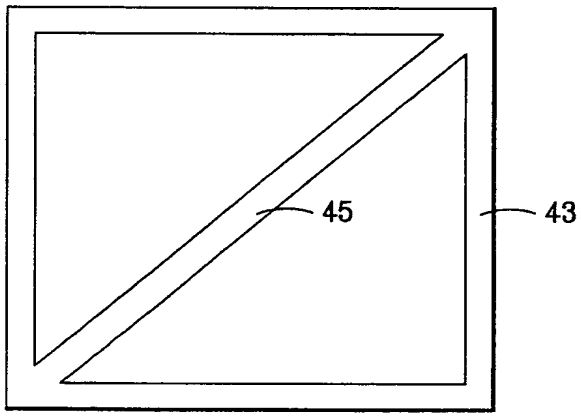
【Fig. 3】



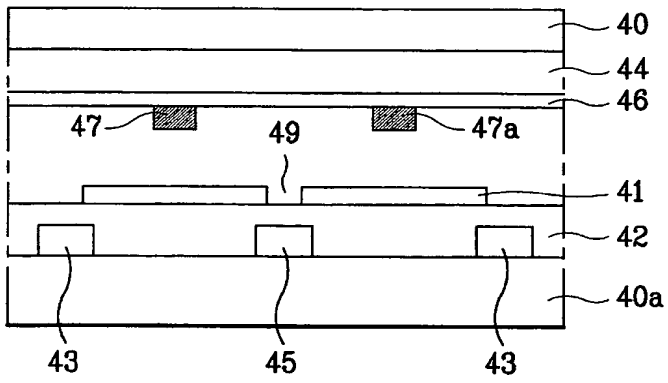
【Fig. 4a】



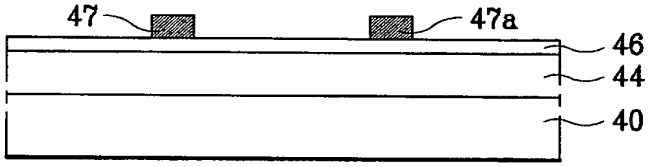
【Fig.4b】



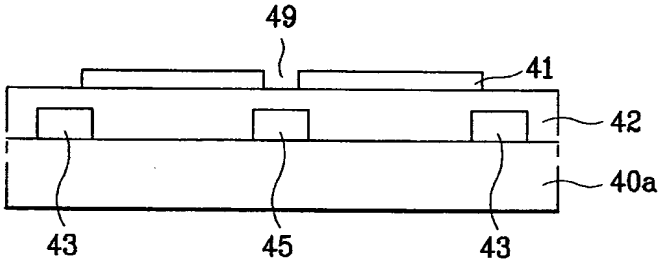
【Fig. 5】



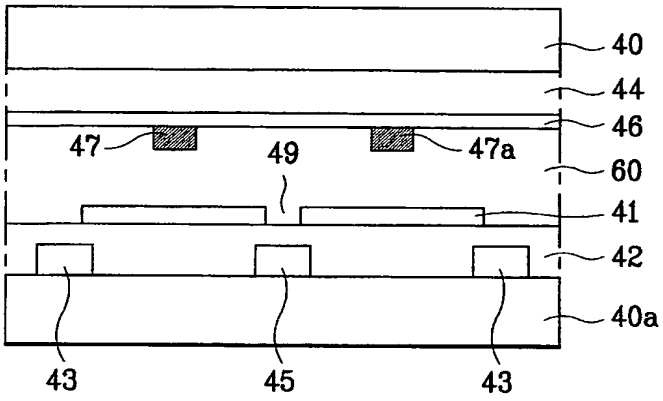
【Fig. 6a】



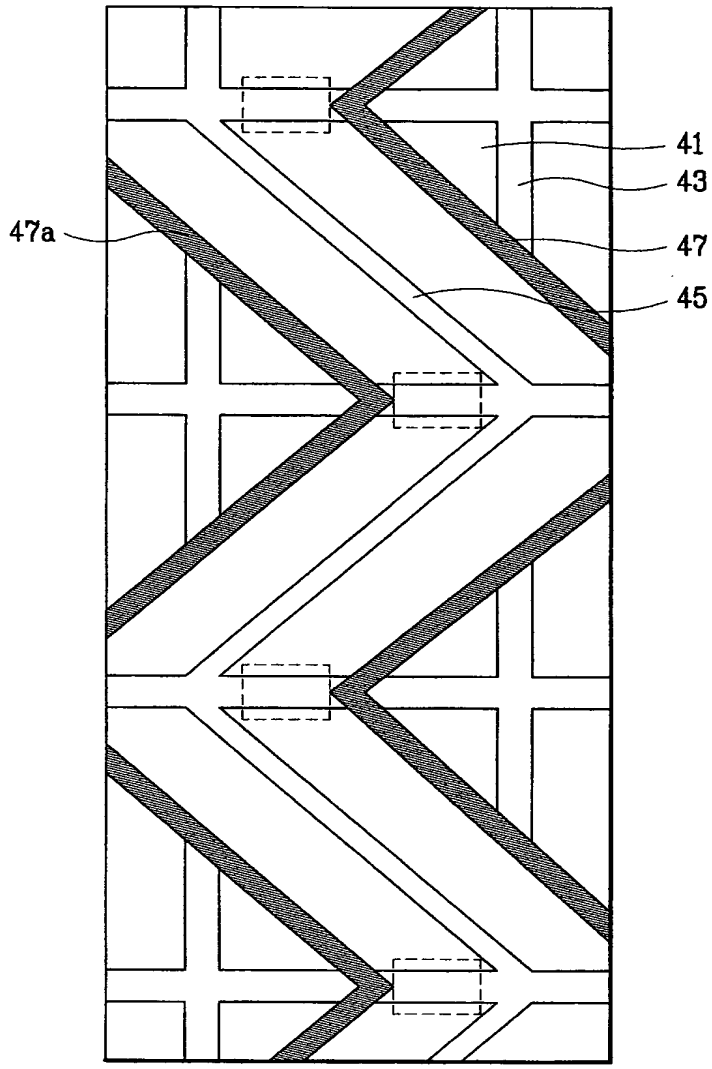
【Fig. 6b】



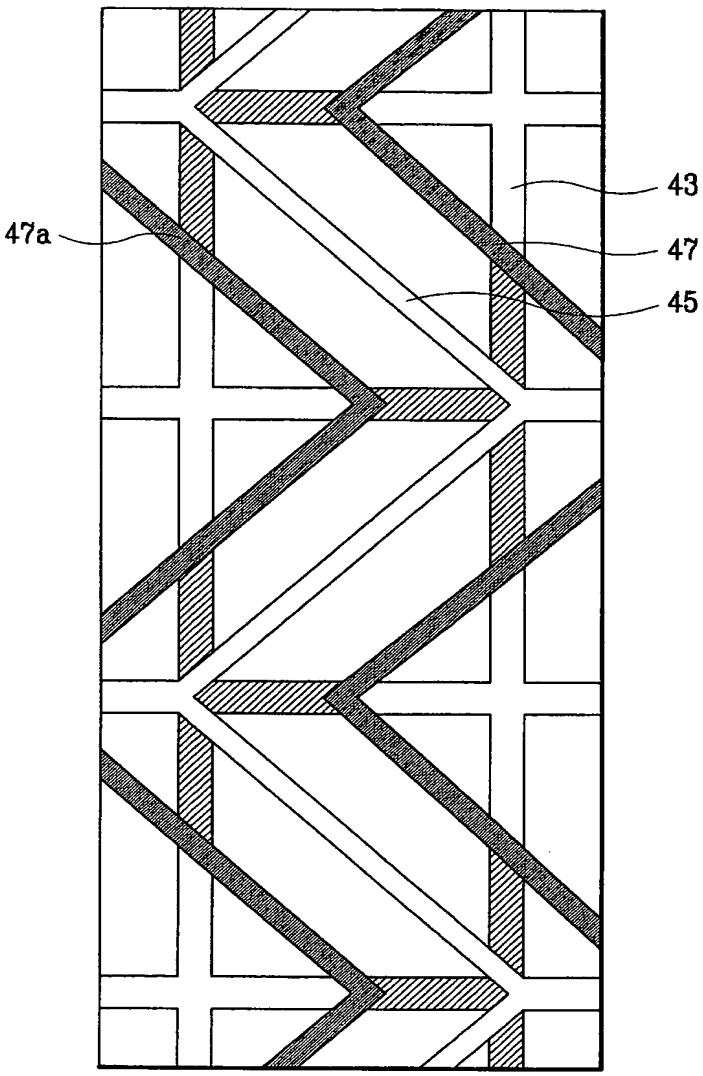
【Fig. 6c】



【Fig. 7】



【Fig. 8】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